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AUTHOR Caddell, Dorothy
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ABSTRACT

Noting that comparisons with international numeracy standards have raised concern about the mathematics attainment of British children, this report provides information to enhance Scottish early childhood practitioner knowledge and understanding of early numeracy and gives practical examples of how to work with young children to develop their skills. Recent research studies into early numeracy are highlighted so that educators can reexamine and develop what they do with confidence and enthusiasm. The report also provides a focus for discussion between parents and professionals, promoting a better understanding of the complementary roles they play and how they can work together to raise children's numeracy knowledge, understanding, and achievement. The sections of this report are: (1) "Early Numeracy: What Does It Mean?"; (2) "Numeracy Begins at Home"; (3) "Children's Knowledge and Understanding of Number Prior to Starting School"; (4) "The Role of Pre-School Settings," discussing the linkage of home and preschool learning, play as a context for early mathematical experiences, and use of nursery routines to provide a mathematics-rich environment; (5) "Reflecting on Existing Practice," related to counting, workbooks and schemes, use of concrete material, mental calculation, organization for learning, game playing, and problem solving; and (6) "Links between Literacy and Numeracy." Contains 20 references. (KB)

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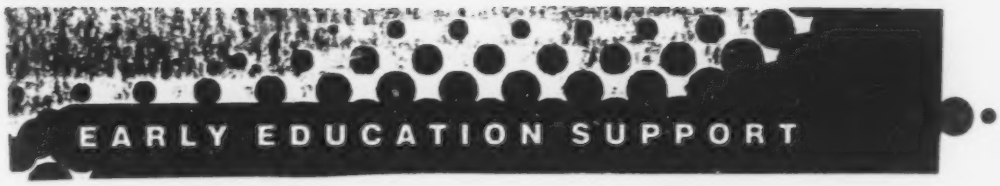

Numeracy Counts

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Numeracy Counts

Dorothy Caddell

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Foreword

Early Numeracy: What Does It Mean?

Numeracy Begins at Home

Children's Knowledge and Understanding of Number prior to Starting School

The Role Of Pre-School Settings

- Linking home and pre-school learning
- Play as a context for early mathematical experiences
- Nursery routines: a mathematics-rich environment

Reflecting on Exisiting Practice

- Counting
- Workbooks and schemes
- Using concrete material
- Mental calculation
- Organising for learning
- Playing games
- Problem solving

Links Between Literacy and Numeracy

Numeracy Counts has been written to encourage educators in the early years to reflect upon their current practice in teaching early numeracy. Comparisons with international numeracy standards have raised concern about the poor attainment of British children and have resulted in our approach to mathematics being 'put under the microscope'. Improving children's numeracy achievement is now a major task for all educators. Very often, when standards of education are called into question, the confidence of educators can be undermined. There is evidence to suggest that educators are less confident about maths as a curriculum area than they are with other areas.

Early years educators have a crucial role to play in developing children's numeracy skills and in stimulating children's interest in mathematics and it is important that practitioner confidence in their role is maintained.

> *Teachers who are confident about the mathematics they teach, and are enthusiastic and effective, stimulate pupils' interest in the subject.*
>
> *Numeracy Matters*. Department for Education and Employment (DfEE), 1998

This document includes information to enhance practitioner knowledge and understanding of early numeracy and gives practical examples of how to work with young children to develop their numeracy skills. It highlights findings of recent research studies into early numeracy so that educators can, in the light of current research findings, re-examine and develop what they do now with confidence and enthusiasm.

The powerful influence that the home and community have on young children's attitudes and educational achievement is now widely acknowledged and the importance of continuity of experience, liaison and progression between home, pre-school and school is increasingly emphasised. Some parents, however, may have negative memories of their own experience of mathematics and as a result feel insecure or inadequate in supporting their children's mathematical learning.

Another important purpose of this document, therefore, is to provide a focus for discussion between parents and professionals, promoting a better understanding of the complementary roles they play and of how they can work together to raise children's numeracy knowledge, understanding and achievement.

EARLY NUMERACY: WHAT DOES IT MEAN?

Concern about levels of numeracy achievement has resulted in a number of developments and initiatives being set up to identify approaches and strategies towards developing early numeracy knowledge and understanding. These initiatives extend beyond the large-scale national, well-publicised developments, to include more local authority level contexts addressing specific needs.

In order to plan and deliver a variety of numeracy programmes which enhance the level of numeracy for individual children it is widely recognised that there is an urgent need for a working definition or description of numeracy to provide educators with:

> *a new and clear framework in which all parties understand their role and can work effectively together toward the common goal.*
>
> *Numeracy Matters* Department for Education and Employment (1998)

Recent definitions of numeracy offer broad agreement about the following.

- Numeracy is more than basic mathematical knowledge and skills. It is not confined to classrooms. It is about action outside the classroom.
- Children must be numerate if they are to cope with the ordinary events and demands of everyday life.
- Children must be able to apply numeracy skills to what they want to do, both to commonly encountered situations and to situations that may not be familiar.

NUMERACY BEGINS AT HOME

The home and family provide a very special place for children's learning, especially in the early years. It is now widely acknowledged that the home provides a rich context for early mathematical activities.

In and around the home, early mathematical opportunities and experiences are presented informally in children's everyday family routines which they share with their parents or other familiar adults.

Did you know?

The provision of appropriate mathematical experiences by parents, rather than pre-school experience or lack of it, has the greatest potential to stimulate and develop children's number knowledge before formal school.

The interactions of parents with children are a crucial factor in determining the nature and extent of mathematical opportunities.

Many parents do not connect the number experiences arising from everyday activities with 'maths in school'.

Parents provide experiences which support and extend their children's early mathematical understandings. Educators need to get a more complete picture about the early mathematical experiences that occur in the everyday family lives of individual children.

Young children see and become familiar with what written numbers look like in a variety of contexts and on everyday items:

- house numbers
- car registration plates
- calendars
- TV remote controls
- buses
- food packaging
- clocks.

They very quickly recognise numbers that have meaning for them: birthdays and ages are particularly important.

Example from practice

Joseph is 3. Joseph's responses show how important his age is to him.
'I'm three. I will soon be four.
'I can count to three ...1, 2, 3.'
When asked to choose some sweets: 'I want three of them.'

Joseph regularly seeks out the number 3 and proudly tells everyone that this is his number.

Children develop an understanding of the purpose of numerals in contexts with which they are familiar. The early experiences they have are highly social and the extent to which young children gain understanding will depend on the adult-child interactions that take place during shared experiences.

In the home setting, children see adults using numbers for a real purpose. They closely observe and listen to the adults around them and watch as they:

- jot down telephone numbers
- select coins when shopping
- fill in lottery tickets
- play games and sports, such as darts.

Watching adults using numbers in everyday situations helps children to realise that:

- numbers give information
  - for dialling telephone numbers
  - to tell us the price of things
  - so we know what time it is
- numbers help us to make decisions
  - deciding which bus to catch
  - choosing the right size of clothes
  - selecting temperature on the oven
- numbers can be fun
  - playing hopscotch in the street
  - playing hide and seek
  - singing rhymes
- numbers can impress!
  Sati and Kirsty are chatting.
  Sati: 'I'm going to the beach tomorrow.'
  Kirsty: 'That's nothing. I've been there hundreds of times.'

In a variety of contexts and situations, parents and other familiar adults act as numeracy models for children. Children often imitate what they have seen familiar adults do.

Example from practice

Sovay (2 years 8 months) re-enacted a measuring scenario using a streamer as a tape measure. She put the tape measure round her father and declared it was '6' as she looked down the numbers. Two months previously she had watched and listened to her grandmother making a dress for her sister and had re-enacted this kind of mathematical behaviour.

Carruthers, E., 'A number line in the nursery: a vehicle for understanding children's number knowledge', *Early Years*, Vol. 18, no.1, Autumn 1997

It is important that parents feel confident and continue to enjoy sharing everyday playful activities involving early mathematical experiences with their child.

Parents need to:

- believe that they can have a positive influence on their child's early numeracy knowledge and understanding
- know how the informal learning that takes place in the home helps their child's early numeracy
- understand how this links to future learning.

Parents often identify game-like activities they have shared with their child as helping their child with number but many find it difficult to understand how everyday conversations and routines with their child offer numeracy activities that are associated with 'maths learning in school'.

The practical challenge for educators is to:

- find ways of showing parents the positive influence they have on their child's early mathematical experiences
- help parents to identify the everyday routines and experiences which can positively influence their child's early mathematical understanding
- support them in their effort to provide appropriate opportunities in and around the home.

Example from practice

Linking child achievement and positive characteristics to parents' efforts

Mrs Grant and her nursery staff have the opportunity for daily face-to-face contact with parents. As they chat informally with parents, sharing with them what their children are doing in the nursery, staff make a conscious effort to link these specific achievements to the support that the parents give to the child in and around the home.

Bridging the gap between learning at home and at school

Often, time to talk to parents as they bring their children to school is limited. Staff in one school, therefore, decided to put together a book of photographs to help parents to identify links between learning at home and school. On one page they displayed photographs of children actively involved in different areas of the nursery. On the page opposite they put photographs of children and parents involved in everyday family routines at home. Captions under each photo emphasised the mathematical experiences offered in the activities in both contexts. A copy of this album is permanently on display in the family room. The staff have made a second 'home-school learning' album and this is taken out on home visits that staff make at the beginning of each session.

Helping parents to understand what goes on in your setting
Parents are regularly invited in to the nursery and Early Years classes to help with specific tasks related to early numeracy. Afterwards staff follow this up with a note of thanks which highlights for parents how their involvement has helped the children's mathematical understanding. Emphasis is put on the adult-child interactions that took place during the activity.

When parents are actively involved in pre-school/school settings they:

- become more confident in their abilities
- know that their contribution is valued
- gain insights into how mathematical experiences are provided through play in nursery activities
- become aware of the importance of interactions between staff and children that effectively enhance understanding of numeracy
- gain more understanding about the importance of asking children for explanations.

However, not all parents/can or want to come into the pre-school or school setting.

Example from practice

Mrs Laing has a Primary 2 class. Children in her class regularly take home a variety of 'home activities' which give parents the opportunity to share mathematical game-like activities with their child. A diary is sent home with the activity to encourage parents to make comments about both their child's and their own experience of working together on the task.

Shared game-like activities:

- give children the chance to reinforce and practise what they have learned in class
- encourage children to display their strengths to parents
- give parents the opportunity to participate in and support their children's early numeracy development in an enjoyable way
- enhance parental effectiveness by offering activities that are developmentally appropriate
- build up over a number of years the expectations that children and parents will regularly share activities in the home.

To gain further insights into effective ways of increasing family participation in 'home-shared activities' further reference should be made to two particular initiatives.

Parent Prompts is an initiative developed in Strathclyde to inform parents of approaches taken in school and to form the basis of activities which parents could undertake with their child in the home setting. The prompts are all tied to specific aspects of 5–14 guidelines and provide an opening for parent and child to share some aspects of the child's learning.

IMPACT (started 1986) is an ongoing initiative set up to encourage parents and children to share maths activities in the home setting. The project has now expanded beyond the UK to Europe, the USA and Canada. The project illustrates how homework tasks can be

adapted to offer opportunities for parents to support their children's learning. The findings of the project suggest that this approach is effective in raising children's achievement and narrows the gap of social disadvantage.

Points to consider

- How can you help parents to identify everyday routines and experiences which positively influence their child's early mathematical understanding?
- Parents may need more guidance in understanding their role: the value of asking children for explanation, clarifications and justifications. How can you offer this?
- Could 'homework' tasks be developed to link the learning that takes place in home and at school? Consider the importance of offering opportunities for parents' feedback.
- Are there existing opportunities for parental involvement in your setting which could be developed further to offer parents specific involvment in early numeracy activities?
- Consider how photographic displays of numeracy activities could help parents' understanding.

CHILDREN'S KNOWLEDGE AND UNDERSTANDING OF NUMBER PRIOR TO STARTING SCHOOL

Young children are learning all the time. To a large extent they choose what they learn. From a very young age, children readily learn what they need to know for everyday life. There is very little difference between what they master and what they actually use on a daily basis.

> *Young children are social beings actively constructing mathematical knowledge through interactions within the physical and social world.*
>
> Aubrey C., 1994. 'An investigation of children's knowledge of mathematics at school entry and the knowledge their teachers hold about teaching and learning mathematics,about young learners and mathematical suject knowledge', *British Educational Research Journal*, Vol. 20, no. 1.

By the time children come to school many of them have experience of different mathematical concepts and skills.

Young children's early knowledge and understanding of mathematics is closely linked to what they do and want to do with numbers. Numbers are familiar symbols. Children recognise written numbers around them. Many children will have heard number names in games, songs and stories shared with familiar aduits. Counting is a social activity. Children learn to count because friends and family count with them as they go up and down stairs. Counting can be important in measuring time: 'How many sleeps until we go on holiday?' Young children's curiosity about size is stimulated from a very early age as they are constantly reminded that they are too small, too big, need to wait until they are bigger.

Children make the most of everything that goes on around them!

Did you know?

Before starting school many children can:

- count
- represent quantities
- share out things
- understand language for comparing and ordering objects.
- recognise numerals
- do simple addition and subtraction
- sort and match items

The amount of mathematical knowledge with which children enter school is a strong predictor of future success.

There can be a significant difference, as much as a three-year difference, in the number knowledge that children have at the beginning of Primary 1.

Programmes in early numeracy are often not well matched to children's prior numerical knowledge because educators very often continue to underestimate the extent of the mathematical knowledge and understanding that children bring to school.

Educators need to:

- become more aware of the rich informal mathematical knowledge that individual children bring to school

- access children's prior mathematical knowledge and experience
- integrate this into pre-school/classroom practice.

The challenge is to find out what children already know, develop strategies which encourage children to display what they can do and to find ways of showing children how their existing knowledge and skills can be used to help them solve problems posed in 'school maths'.

Points to consider

Many pre-school settings carefully structure their 'settling-in period' to ensure that time can be spent with new parents to discuss the child's achievements to date. 'All about me books' encourage parents to share ongoing home experiences.

- How can you gather more information about the mathematical knowledge that individual children have before starting school?

In the more formal setting of school, educators may not have the opportunity for regular meetings with parents. Written records passed on to them by colleagues in pre-school settings contain valuable information about children's achievements and understanding.

- What use do you make of the profiles passed on to you from other contexts?

Presenting children with problem-solving tasks which incorporate familiar objects can encourage children to display what they know.

- What strategies could you develop to encourage children to share with you what they know?

THE ROLE OF PRE-SCHOOL SETTINGS

For a growing number of children, the pre-school setting is often their first step out of the home setting. The activities and opportunities that children experience in the home are different from those they will experience at school. Staff in pre-school settings have a crucial role to play in ensuring an effective transition for the child from the home to pre-school.

Children come into pre-school settings from a variety of backgrounds and with a wide diversity of numeracy experiences. We would expect children who have had early experience of number in and around the home to be those children who recognise and make use of numbers in pre-school.

Did you know?

Even although children readily recognise written numbers in everyday meaningful contexts in and around the home, they often find it difficult to link what they have already learned with their pre-school experiences.

If maths is not presented to children in a way which makes sense to them then there is the danger that children will not see what they have already learned in the home as being of any value or use to them in their new setting.

Early educators have an important role to play in helping young children to gradually transfer their existing mathematical skills to new situations.

LINKING HOME AND PRE-SCHOOL LEARNING

A number of possible key characteristics of the home and school as environments for learning have been identified which can tell us more about the nature and quality of learning that takes place in these contexts. Consider the aspects of home-school learning set out in the chart below. This will enable you to get a clearer picture of the routines and situations that have first supported their learning and help to identify links between what children do in your setting and the learning opportunities offered in the home.

	Home learning	**Nursery/pre-school**
Adult/child ratio	High	Low
Adult roles	Model	Instructor
Resources	No special resources	Supported by special resources
Types of activity	Natural problems, often spontaneous	Contrived problems, timetabled

Adapted from Hannon, P., *Literacy, Home and School*, The Falmer Press, 1995

PLAY AS A CONTEXT FOR EARLY MATHEMATICAL EXPERIENCES

Children in pre-school settings freely choose from a wide range of play activities. In the early years play is widely acknowledged as a meaningful and valuable context for all aspects of young children's development and learning.

In terms of early numeracy, play gives children:

- opportunities to revisit numeracy tasks they are familiar with
- challenges which encourage them to link past and present experiences
- choice of early mathematical experiences to match their skills and stage of development.

Did you know?

Recent research supports the early years approach of developing children's mathematical thinking through play.

Young children's mathematical thinking is developed through a variety of activities based on their play in different areas of the pre-school setting.

Play areas in pre-school settings mirror 'real life situations' and educators need to consider how children can be encouraged to build on the mathematical knowledge and understanding that they have gained in and around the home as they work and play in these areas.

Effective learning does not depend solely on organisation and resources. Children's understanding of numeracy relies on repeated and varied activities. Early years educators carefully plan and organise a variety of material resources and activities to develop children's early numeracy but they also have a crucial role to play in helping children to make their own meaningful mathematical experiences in the play context. Young children rely on sensitive adults to support and guide them as they explore new mathematical experiences.

Some ideas for nursery and pre-school mathematical experiences

- Organising the cars so they all fit into the car park
- Looking forward to becoming 5 years old
- Guessing how high the aeroplane is
- Building a wall that the wolf can't blow down
- Buying fruit to make a fruit salad
- Making a tent big enough for all my friends
- Sorting and putting away my toys
- Printing patterns on fabric for curtains in the home corner
- Wondering why the tall thin bottle holds less than the short fat bottle
- Noting whose sunflower has grown the tallest
- Planning a cafe in the role play area – what goes where?

Let's Get It Right, Leeds City Council, 1996

Talk is a natural, effective and crucial strategy.

Menmuir, J. and Adams, K., 'Young children's inquiry learning in mathematics', *Early Years*, Vol. 17, no 2, Spring 1997

The adult's input is crucial. The more quality interaction a child experiences, the more effective a child's learning will be. The interactions that early educators have with children affects the extent to which children develop mathematical understanding. When adults act in a supportive and encouraging way, numeracy experiences are more likely to take place. One-to-one adult-child interactions are particularly effective.

Did you know?

Links have been identified between enhanced numeracy experience and organisational systems which assign children to particular adults.

Examples from practice

The Butterflies nursery has three members of staff. 30 children attend the nursery on a full time basis. Each member of staff has responsibility for 10 specific children. Susan, one of the nursery nurses, feels that their 'key worker' system gives her the opportunity to form close relationships with her particular children. Anne, the other nursery nurse, comments that she enjoys having more time to get to know the parents of these individual children and Margaret, the nursery teacher, values the sharing of insights they each have into the level of competence of individual children. Their detailed understanding of what children within their group can do helps them decide what experiences they go on to provide to support and challenge each child's existing knowledge.

NURSERY ROUTINES: A MATHEMATICS-RICH ENVIRONMENT

Children develop increasing independence through being involved in nursery routines. Many of these routines are similar to everyday family events that they share with their parents. Nursery routines offer opportunities for children to develop their understanding of maths and to put into action the mathematical knowledge, skills and understanding they have acquired in and around the home.

Daily nursery routines such as brushing teeth, snack, hanging coats on pegs, tidy up time, etc. can be organised to provide opportunities for children to experience some of the aspects of numeracy listed.

Nursery routines	Mathematical experiences
	• develop powers of observation using senses • recognise patterns, shapes and colour • be aware of daily time sequences identify and use numbers up to 10 • sort and categorise things into groups • count • recognise some properties of materials, such as hard/soft/smooth/rough • solve problems • use words to describe measure • collect, organise, display, interpret

Children should be encouraged to understand maths in their environment, use it and make sense of it.

Examples from practice

Numbers help keep order

Miss Anderson gathered the nursery children around her at story time. Before starting the story she explained to them that recently the sand area had been very crowded.

'We only have three spades in the sand tray. How can we make sure that only three children play in the sand at one time?'
The children suggested making a sign for the sand area with a picture of three children on it.
Ross said he could write the number 3.
The children made signs for the area.
The next day, Joe changed 3 to 4 and joined three other children in the area!

Tidy up time

Scissors in the nursery are stored in sets of six slotted into holes in colour coded boxes which match the colour on their handles. At tidy up time Mrs Bankhead encouraged the children to make sure that all of the scissors had been returned. Often the children had to search for at least one missing pair of scissors!

In making sure that the sets were returned, children experienced matching colours, one-to-one correspondence, counting to 6, simple addition and subtraction.

Observation of children's early mathematical engagement is crucial to identify ways of supporting and challenging children's existing mathematical thinking. Early educators rely on observations to identify and assess children's learning. Close attention to the detail of children's play and interactions is needed to give practitioners insight into how children's mathematical thinking is developing.

Did you know?

When observing children's mathematical experiences:

- educators focus primarily on what the child says and rarely record non-verbal action
- educators focus on sorting and matching activities and have less understanding of other aspects of numeracy.

Practitioners need to identify the wide range of mathematical experiences children engage in.

Children often make their development of maths understanding visible in the way they manipulate play materials. For example, as they use construction bricks and blocks, children:

- combine different sizes and shapes effectively
- make patterns
- organise bricks and blocks to complete constructions
- estimate and measure
- solve real problems
- begin to understand proportion.

Examples from practice

Ms Carruthers, with the help of children in the nursery, created a 'touch and feel' number line. The numbers were about half the height of a four-year-old. Children were invited to decide what number should be the starting number. Personal numbers were the first to be chosen. Children decided on the number 3, a very personal number, the age of many of the children. After 3, 4 was chosen (the age of many of the other children in the nursery). Toby chose the number 8, his brother's age.

Over a period of time, and initiated by children's interest, new numbers were added. Spaces were left for numbers not yet chosen. On each occasion children had to estimate where the new number should be placed in relation to the numbers already on display. Children helped Ms Carruthers to cut out each of the numbers and chose from a variety of materials, (pasta, foil, etc.) to 'fill in the numbers'.

Observing the children around the number line gave Ms Carruthers information about what the children knew, the interactions they had and the different ways in which individual children used it.

The number line:

- encouraged children to try out the number sequence for themselves
- encouraged children to display their individual levels of knowledge and interest in number
- provided a focus for adult-child, child-child talk
- prompted children to initiate their own games around the numbers on the line
- generated an interest in 'having a go' at writing numbers.

Carruthers, E., 'A numberline in the nursery: a vehicle for understanding children's number knowledge', *Early Years*, Vol. 8, no.1, Autumn 1997

Points to consider

- How can you organise existing resources to encourage children to use mathematical language of shape, of position and of comparison?
- How can you offer opportunities for children to create and copy patterns and to explain the patterns they make?
- What resources could you add to create a numeracy environment?
- How can you provide opportunities for children to use numbers they are familiar with?
- Could you develop an observation 'frame' to assist you in identifying the wide range of mathematical experiences children engage in?

REFLECTING ON EXISTING PRACTICE

Over the past three decades there has been little change in the structure and content of the early years maths curriculum. Approaches to teaching maths in the early years continue to be strongly influenced by Piagetian views of numeracy. Piaget's main assertion was that, before the age of 7, children cannot conserve number and that children must first understand this before they can develop the concept of number. As a result, educators in the first year of school introduce children to a variety of pre-number sorting and matching activities to 'get them ready' for number work.

Did you know?

The early years curriculum may be most suited to least advanced children because more advanced children are not provided with appropriate opportunities and challenge to progress.

Children who have no formal experience of pre-number sorting and matching activities do gain a significant understanding of number within weeks of starting school.

Counting is important to the development of children's understanding of basic number concepts.

Recent research suggests that counting rather than sorting and ordering should be the basis of the early years curriculum.

COUNTING

Very young children love to count. Counting is very often an activity shared with others. Children learn the difference between counting words and non-counting words at a very early age. Children counting 'right up to 100' as they play hide and seek often provides entertainment for any adults who happen to be listening in!

To count correctly children need to:

- recall words in the right order
- co-ordinate hand, eye and voice
- keep track of what has or has not been counted.

Counting is a complex activity but children's beliefs about counting do not reflect this. Many children believe that counting is something they learn to do by themselves with little help from others.

Did you know?

Children believe that counting is 'saying the words in the right order'.

They commonly confuse the notion of 'counting' with 'reading' numerals.

Children need to understand why we count. Educators need to structure counting activities carefully so that children can see counting as something we do to find out how many things there are. There are many opportunities to offer experiences in everyday pre-school school routines:

- registration
- counting shared food at snack
- playground games.

Did you know?

When adults count along with children, they encourage the spoken language of counting.

When children watch someone else counting, they concentrate on the counting process.

Educators need to encourage children to build on the range of strategies which they themselves have developed for counting. Children often use their fingers for counting. This may be useful with small numbers but children may have to develop different methods to deal with larger numbers.

Example from practice

Jane (7) was very successful using her fingers to subtract from numbers less than ten. 9 – 2 caused her no problems. Without counting, she extended nine fingers. Again without counting, she curled down two of them and, yet again without counting, she looked at the remaining extended fingers and said 'Seven!'. Her earlier experiences of using her fingers for counting had assimilated to the point where she could subitise (quantify without counting) amounts with her fingers very easily but such a procedure could not be used for 11 – 2. She had to attempt counting but she only had ten fingers. It took her several seconds to devise a method which involved counting her left thumb twice then subitising the remainder. On this occasion she was successful but an attempt to modify the same method caused horrendous difficulties when she attempted 20 – 5.

Gray, E., 'Children Counting', *Education 3–13*, October 1995

Here are brief descriptions of four different stages of counting.

1. Ben can only count items that he can see (and touch) in front of him.
2. Matt does not have to be able to see items to count them, but he still visualises items he cannot see by making hand movements in the air to 'represent' each item as he counts.
3. When Liam is asked to add two more items onto an existing three (3 + 2) he counts 3...4...5. (Matt and Ben would still find it necessary to count on from the first item 1...2...3...4...5.)

4. Beth is able to use 'count down to' strategies. When presented with '17 – 12' she replies 5 and explains how she got the answer by sequentially putting up her fingers 16...15...14...13...12.

Educators need to watch and listen to children as they count, and need to develop strategies to help children extend these methods. Children initially use a variety of counting strategies to make senses of addition and subtraction.

Think about individual children in your class. Can you identify their stage of counting from the description of these four stages?

Points to consider

- Do you encourage playful counting in day to day activities?
- Do you share experiences with the children which make the purpose of counting explicit?
- How can you create situations which encourage children to count for the purpose of finding out how many?

One little boy told me that he usually counted his yoghurts when he got home, because his mother always pretended she had eaten some while he was at school.

Munn, P. 1997, cited in *Teaching and Learning Early Number*, Thompson, I., (ed), 1997

WORKBOOKS AND SCHEMES

In most schools, maths programmes are delivered through commercial schemes and workbooks. These provide individual classroom teachers with a structured content and a conceptual framework which allows them to plan their maths programme.

Textbooks play an important role in the planning and teaching of early maths. Many educators rely on published schemes to:

- inform their planning
- guide them in deciding what teaching strategies to adopt
- help them develop materials they use
- check children's understanding
- learn about subject content.

There is, however, a growing recognition of the need to review critically textbook activities and approaches to ensure that they guide teachers towards developing early numeracy using strategies reflected in recent research.

The value of published material is questioned when it:

- encourages a narrow range of teaching styles
- emphasises the need for pre-number work to precede number work
- consists of exercises which limit the strategies children use to develop number sense.

Did you know?

Research comparing approaches to teaching maths in British and continental textbooks has highlighted a number of important differences in the emphasis given.

- Continental textbooks emphasise that 3–5 times as much time should be spent on practice and consolidation as on the introduction of new concepts.
- There is less variation in the presentation of the exercises. Their view is that children get unnecessarily distracted if exercises are presented in too many different forms.
- Arithmetic is given much greater weighting.
- In the first year of school the emphasis is on number work to 20 and in the second year to 100.
- Mental calculation is given priority over pencil-and-paper calculations until the age of 9.

It is important to spend more time on practice and consolidation before introducing new concepts. Very often, as soon as educators know that a child has achieved a particular skill or level of understanding, they introduce them to another new, more complex concept. (Children often judge how much they are learning by what page they are on!)

Educators need to link consolidation and practice to real events and objects in the children's lives. Workbooks can be used to give individual children the opportunity to practise concepts they have mastered in problem-solving experiences with real objects in the contexts of their everyday lives.

With practice, children:

- become thoroughly familiar with the new concept learned
- use new concepts with increasing speed and ease
- are given the opportunity to gain understanding of the relationship between new concepts learned and previous learning.

> *An effective teacher of mathematics conveys information to children personally, rather than relying too much on curriculum material of textbooks. Although individual practice is important, leaving children to do too much practice on their own gives little opportunity for interaction between pupils and their teacher.*
>
> *Numeracy Matters*. Department for Education and Employment, 1998

Points to consider

- How do you ensure that you provide adequate opportunity for child-teacher interaction?
- What strategies do you use to give children opportunities to practise new concepts in real events?

USING CONCRETE MATERIAL

Children in the early years are encouraged to use concrete materials such as beads and cubes to work out the answer to arithmetic sums. Educators believe that when children use practical materials maths is made more 'real'; concrete materials encourage children to 'discover' number relationships for themselves.

Educators often allow children to continue to use practical materials for as long as they seem to need them. Frequently it is left to the children to decide when they are ready to work without these. Children, however, need to be encouraged to move on to more advanced strategies.

Did you know?

Children's understanding is not necessarily enhanced by the use of concrete material.

Children often find it difficult to have a clear idea about the purpose of the practical materials they are offered.

Overuse of concrete material can emphasise the development of skills at the expense of making more sense of number.

Practical materials can be used as a means for guided discovery and an aid to instruction if educators:

- take into account the children's existing knowledge and skills
- are clear about why the apparatus is useful
- actively guide children in their use of the materials.

Points to consider

- How can you provide contexts in which meanings are established and extended?
- Do you encourage children to explore relationships?
- Do you demonstrate a range of techniques?

MENTAL CALCULATION

When solving problems in everyday life, adults rarely draw on their past school experience. They do not usually make connections between how they solve problems in a practical situation and the written calculation methods taught in school. They use informal methods of calculation.

Informal methods of mental calculation are:

- intuitive
- flexible
- easily adapted to suit specific problems
- often more accurate than written methods.

Methods of mental calculation are important in helping children to understand number and to use it effectively. Regular oral and mental work develops children's calculation strategies and recall skills.

Did you know?

Recent research stresses that mental calculation must be given a higher priority. There is a need for 'a shift towards calculating in the head rather than on paper'.

Children are remarkably good at developing their own sophisticated and efficient forms of mental calculation to fit with their level of understanding.

Mental strategies used by children differ from those used by adults.

Many parents and educators will remember 'doing mental' at school, in which the teacher stood in front of the blackboard calling out the 'daily dozen'. You may remember handing your list of answers to the child sitting next to you to mark with a tick or a cross, and waiting for the teacher to ask who had them all right: one wrong, two wrong etc.? Rarely was there any discussion of how answers were obtained!

Educators need to plan regular mental calculation sessions to give children more practice in mental calculation.

The sessions should be set in a context which captures children's interest.

Example from practice

Mr Fraser's Primary 2 children look forward to their regular mental calculation session. Sometimes they play games. Their favourite game is one which they helped Mr Fraser to make. They cut out pictures of people from magazines and glued them on to little pieces of card. The children decided on an age for each of the people and wrote it on the picture. A number of different questions cards were made to make the cards into a game, for example: 'How much older is ___ than ___?'

Children should be encouraged to develop a range of mental methods of calculation by discussing how answers are obtained, and encouraging discussion of different ways of doing calculations both with each other and with the teacher.

Discussion with children:

- helps children to see the value of more complex strategies
- encourages them to adopt or adapt existing strategies.

Listening to children:

- reinforces that their ideas are valued and can give them the confidence to solve further mathematical problems
- identifies the strengths and limitations of individual children's understanding and helps children to overcome difficulties.

Points to consider

- Do you have regular mental calculation sessions? If so, do you encourage discussion between children and with you of how answers are obtained?
- How can you encourage children to develop a range of mental methods of calculation?
- What activities could you develop to make sure that mental calculation practice captures children's interest?

ORGANISING FOR LEARNING

Recent research suggests that teachers focus on **what** to teach not **how** to teach. They concentrate on covering the curriculum and on making maths "stimulating and fun" not on the effectiveness of the activities in enabling children to develop understanding and master numeracy concepts.

Careful organisation is an important factor in providing early mathematical experiences for young children.

Did you know?

Development of children's early numeracy does not depend solely on carefully considered organisation and resources.

The numeracy experiences children have must be within the context of social interaction.

Young children make sense of the world as a result of meaningful interactions with the adults around them. Educators play a crucial role in encouraging children to interpret and reflect on their mathematical experiences at all stages of learning.

> *The more quality interaction a child experiences the better will be the learning outcome.*
>
> Munn, P. and Schaffer, R., 'Literacy and numeracy events in social interactive contexts', *International Journal of Early Years Education*, Vol. 1, no.3, Winter 1993

> *Mathematics is primarily an activity of the mind, closely bound up with the social context in which it takes place. It is interaction and discussion with real people rather than action with objects, that contributes to the development of abstract reasoning and mathematical thinking.*
>
> Merttens, R., *Teaching Numeracy: Maths in the Primary Classroom*, Scholastic, 1996

Educators need to:

- share with children the significance of resources and encourage them to make meaningful use of the material
- maximise opportunities for interaction
- have a clear view of their mathematical agenda and direct activity and discussion towards this.

A study carried out by Aubrey (1995) highlighted features of successful practice in early numeracy:

- segments of lesson were clearly defined
- goals and purposes were clearly defined
- relevant existing skills and knowledge were assessed before being deployed in lesson
- links were made between old, familiar and the new
- as new concepts were added, verbal demonstration link to key actions
- verbal and physical moves were linked
- there were very few question and answer feedback sequences.

Support strategies observed in the study included:

- choral counting to allow scaffolding of those in the group who were less confident.
- talking aloud to give children simultaneously a verbal and concrete representation, for example:
  'I've got four counters. Three are yellow. I'll put the three yellow counters on the mat and the blue over there.'
- incorporating the child's comment into your reply to introduce addition naturally, for example:
  Child: You don't have many blue counters.
  Educator: No, I don't have many blue counters. I only have one but how many counters do I have altogether?
- linking verbal representation to the child's physical action to reinforce it.

The study concluded that the successful educator:

- shows a sensitivity to children's abilities
- motivates the children
- keeps them on target
- provides positive feedback.

Points to consider

- How can you set up situations which encourage children to clarify, predict, look for alternatives?
- To what extent do you offer opportunities for group work, paired work, and whole class teaching?
- Do you provide regular positive feedback to children?

PLAYING GAMES

Conversational exchanges are important for early understanding of number. Games encourage mathematical talk. Children of all ages love to play games. Many of them will have played games at home with family and friends. Games offer an opportunity for children to link experience of number at home and in school. In games numbers are objects of play. When games are played, materials are used that are of interest to children and they help create an atmosphere that builds confidence to question, challenge and reflect.

Did you know?

Mathematical talk:

- helps children to make sense of mathematical ideas
- helps consolidate understanding and encourages children to organise and clarify their thoughts (children can share partly formed ideas with others)
- encourages reflection and recall
- builds children's confidence
- helps develop a sense of ownership of maths activity
- uncovers the level of pupil's mathematical understanding for the teacher and so aids assessment.

Examples from practice

Staff spent one of their planned activity sessions gathering together all of the games in their resource area. They then catalogued them according to the specific maths concepts that they could be used to teach. (For example, dominoes encourage children to count the dots to find out how many there are and to match these to another domino with the same number.) Cataloguing the games ensured quick and easy access to the games when needed. The discussing and making decisions about the specific aspects of maths provided by the games strengthened and extended the teachers' understanding and knowledge of maths.

A maths games library was set up in the Primary 2 class. Children were actively involved. They helped to number the games, write out the rules of the games and designed little borrowing cards with dates on them. Children could choose a game to take home for a week.

Organising the library gave children experience in:

- writing and recognising numbers
- sequencing
- the role of numbers in dates.

It is worth considering how games can be extended beyond the classroom by painting outlines or patterns on the playground, for games such as hopscotch.

PROBLEM-SOLVING

Problem-solving activities can provide a link between mathematics and the reality of young children's lives.

Maths activities rooted in children's experience:

- enhance the child's interest in the solution
- increase the child's attention to detail
- encourage a gradual transfer of knowledge of skills to new situations.

Challenges need to be clearly understood by the children, motivate the children, and be rooted in children's reality.

Example from practice

Children in a Primary 2 class were asked to find out who had the biggest smile in the class. A range of materials such as pipe cleaners, straws, lipstick, paper streamers and plasticine were provided. Children were asked to plan in groups how they would determine the biggest smile in their group and which materials they would use. As a group they needed not only to measure smiles but also to decide which was the biggest –this usually resulted in much discussion and interesting graphic representations of the smiles.

Asking children to record the results of their group in a way that could be shared with others in the class encouraged creative means of recording.

Groves and Stacey, 'Problem Solving – A way of linking mathematics to young children's reality', *Australian Journal of Early Childhood*, Vol. 15(1), March 1990

A challenge such as the one described in the previous example:

- encourages children's natural curiosity
- allows children to try out their own strategies
- gives children opportunities to see for themselves advantages of different, more effective approaches
- gives children an identified audience and a purpose for the communication
- encourages different strategies to be compared and considered in terms of efficiency and accuracy.

LINKS BETWEEN LITERACY AND NUMERACY

Children do not always necessarily discover good procedures for themselves. You may need to introduce them to more efficient ways of tackling the problem.

Points to consider

- How can you design activities which can be solved in number of ways?
- How can you encourage children to interpret and reflect on their experience?

Many schools have developed comprehensive literacy intervention schemes to address recent concern about levels of literacy achievement. Evaluation of these has helped to identify elements of practice which support and encourage children's early literacy development, and valuable insights have been gained into various strategies and resources that can be effective in enhancing approaches to language and literacy. The main impact has been to put the focus firmly on the child and what the child can do and not what educators think they should know. There is evidence that educators are enthusiastic and more confident in deciding how to provide opportunities for 'emergent literacy' through play.

Did you know?

Children's literacy and numeracy learning have a number of things in common.

Like literacy, numeracy is an important tool for gaining access to the wider curriculum.

Both are reliant on adult interactions.

Children's literacy or numeracy thinking is only likely to develop if they are immersed in a literacy or numeracy-rich environment.

It is important that children's literacy or numeracy takes place in meaningful social contexts.

Both literacy and numeracy development depend on the growing ability of young children to understand and manipulate symbol systems.

Without the ability to read and understand, no one can become mathematically literate. Increasingly the reverse is also true: Without the ability to understand basic mathematical ideas one cannot fully comprehend modern writing such as that which appears in newspapers.

Everybody Counts: Report to the Nation on the Future of Mathematics Education. National Academy Press, USA 1989

Certain aspects of a language programme are important in developing early literacy. Stoessiger and Wilkinson (1991) identified the following features as significant.

- Children make choices.
- A literary environment is established.
- Children 'scribble'. They write in non standard ways. Whatever the child produces is accepted as writing.
- Talking is valued.
- The teacher often acts as a scribe to record what the child says.

Despite links between literacy and numeracy being identified, teachers still treat literacy and numeracy separately from each other in their educational practice.

Did you know?

Teachers are often reluctant to allow young children to record mathematics in a similar way to literacy.

Children are less likely to see adults writing numbers for a purpose than they are written words.

Teachers expose children to more sophisticated language than they would expect them to use whereas children are only shown mathematics that teachers assume they will be capable of dealing with.

Teachers find it harder to develop challenging open activities for number than they do for shape and measurement.

Look carefully at these points and consider the implications for your practice.

Writing Maths

> *Writing should be meaningful for children, ... an intrinsic need should be aroused in them and ... writing should be incorporated into a task that is relevant to life.*
>
> Vygotsky, L.S., *Mind and Society: The Development of Higher Psychological Processes*,Cambridge, Mass, Harvard University Press, 1978, cited in Hughes, M., *Children and Number*, Basil Blackwell, 1986

Young children from an early age begin to represent numbers in their own way. Before they come to pre-school/school many children may already have had a go at writing numbers that are meaningful to them. Children's attempts at writing numbers will vary widely: from scribbly marks to conventional numbers. The following chart shows some iconically used numerals. Links can be made between counting and writing strategies.

Conventionally used numerals

Iconically used numerals

Hieroglyphs

Tally marks

Pictograms

Pretend Writing

From Munn, P. 'The early development of literacy and numeracy skills', *European Early Childhood Educational Research Journal*, Vol. 2, no.1, 1994

Did you know?

Although the marks and pictograms that children make look as if they represent quantity, children with a poor concept of number do not use them to find out how many.

Children's ability to communicate quantity is linked to their knowledge of counting and concept of number. Early educators often use pictograms to help children understand the meaning of number but these may not be any more helpful in enhancing understanding of quantity than the use of conventional numerals. It is important for all children to have access to the conventional numeral system.

When offered opportunities to 'write' their own maths stories, young children:

- are happy to invent their own methods
- gain confidence to 'have a go' at things they may see as beyond them
- are encouraged to demonstrate what they know.

Educators need to:

- encourage children to make own marks
- value children's early attempts at writing numbers.

Giving children responsibility to represent their own experiences establishes a process to span the gap between children's experience and the mathematical symbols.

Pengelly, H., 'Freedom to think, structure to learn', *Prime Number* 4 (1), 13–18, 1989, cited in Groves and Stacey, 'Problem solving – A way of linking mathematics to young children's reality', *Australian Journal of Early Childhood*, Vol. 15(1), March 1990

Example from practice

Christopher wrote 817 and explained to his teacher who was standing nearby, "There were eight eggs and one broke so there were seven left." He reversed the symbol for seven. Surprised and pleased, his teacher asked him

what would happen if two eggs were broken. He wrote 826. Chrisopher had neither the symbol for subtraction nor that for equality but he was happy to invent his own method.

Allowing children to make their own representations gives teachers insights into the child's starting point. Seeing children's thinking emerge is particularly valuable for teachers. It provides the information teachers need to help them to take the children further.

Children's existing thinking has to be challenged. In language this happens through story reading and use of books. Texts used for reading can be rich in mathematical material.

'While teachers and parents often use children's stories to develop language and to stimulate art activities, the fact that stories are a rich source of mathematical ideas is often overlooked.'

Books offer opportunities for numeracy skills to be consolidated, practised and extended.

The potential of rhyme and music activities in developing children's understanding of early numeracy can also be considered.

Research tells us that children experiencing success in early literacy:

- demonstrate an awareness of why something is being taught
- use strategies taught
- use strategies when they understand their usefulness
- need to realise the value and importance of strategy
- need to be taught technical language.

What challenges do these present for our approach to early numeracy?

Points to consider

- How can you provide a variety of writing situations which encourage children to make their own number stories?
- Do you model the writing of numbers?
- Do you value children's own attempts at writing numbers?
- How can you provide a range of situations in which children can sh[illegible] writing experiences with other children?

Educational change depends on what teachers do and think – it 's as simple and as complex as that.

Fullan, Michael G., with Stiegbauer, Suzanne. *The New Meaning of Educational Change*. Cassell, London, 1991

Aubrey, C. 'An investigation of children's knowledge of mathematics at school entry and the knowledge their teachers hold about teaching and learning mathematics, about young learners and mathematical subject knowledge', *British Educational Research Journal*, Vol. 20, No. 1, 1994.

Aubrey, C. 'Maths from a tube of Smarties', *Education 3–13*, March 1995, pp. 35–44.

Carruthers, E., 'Talking numbers: a development link between literacy and numeracy', *Early Education*, Summer 1997.

Carruthers, E., 'A number line in the nursery: a vehicle for understanding children's number knowledge', *Early Years*, Vol. 18, No. 1, Autumn 1997, pp. 9–14.

Department for Education and Employment (DfEE), *Numeracy Matters: The Preliminary Report of the Numeracy Task Force*, 1998

Everybody Counts: Report to the Nation on the Future of Mathematics Education, USA: National Academy Press, 1989.

Fullan, Michael G., with Stieglerbauer, Suzanne, *The New Meaning of Educational Change*, Cassell, London, 1991.

Gray, E., 'Children counting', *Education 3–13*, October 1995, pp. 36–40.

Groves and Stacey, 'Problem Solving – a way of linking mathematics to young children's reality, *Australian Journal of Early Childhood*, Vol. 15(1), March 1990.

Hannon, P., *Literacy, Home and School*, The Falmer Press,1995.

Hughes, M., *Children and Number*, Basil Blackwell, 1986.

Leeds City Council, *Let's Get It Right*,1996.

Menmuir, J. and Adams, K., 'Young children's inquiry learning in mathematics', *Early years*, Vol. 17, No. 2, Spring 1997.

Merttens, R., *Teaching Numeracy: Maths in the Primary Classroom*, Scholastic, 1997.

Munn, P., 'The early development of literacy and numeracy skills', *European Early Childhood Education Research Journal*, Vol. 2, No. 1, 1994.

Munn, P. and Schaffer, R., 'Literacy and numeracy events in social interactive contexts', *Internationall Journal of Early Years Education*, Vol. 1, No. 3, Winter 1993.

Pengelly, H., *Freedom to Think: Structure to Learn*, 1989.

Stoessiger, R. and Wilkinson, M., 'Emergent mathematics', *Education 3–13*, March 1991.

Thompson, Ian, *Early Years mathematics: Have We Got It Right?*, 1997.

Vygotsky, L.S., *Mind and Society: The Development of Higher Psychological Processes*, Cambridge, Massachusetts, Harvard University Press, 1978.

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